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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN THE MATTER OF THE APPLICATION FOR PATENT

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| INVENTOR: Noboru UENISHI et al. | DOCKET NO.: 4863 |
| APPLICATION NO.: 10/532,543 | CONFIRM. NO.: 3819 |
| FILING DATE: April 22, 2005 | ART UNIT: 3742 |
| TITLE OF INVENTION: Electrode Material for Electrical Discharge Machining and Method of Manufacturing the Same | EXAMINER: M. A. ELVE |

MS AMENDMENT
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DECLARATION OF UNEXPECTED RESULTS UNDER 37 CFR 1.132, INCLUDING AN ATTACHED COVER SHEET WITH CERTIFICATE OF TELEFAX TRANSMISSION

Honorable Commissioner:

We the undersigned inventors of the invention of the above identified patent application each hereby declare as follows:

1) Mr. Norihito Goma, one of the inventors of the invention of the above identified patent application, has conducted comparative testing as will be explained herein, to demonstrate unexpected

results according to the invention in comparison to US Patent 4,027,134 (Arakawa et al.). Mr. Goma graduated from The University of Electro-Communications, Department of Applied Physics and Chemistry in March 1994. In April 1994, he began working at Sumitomo Electric Industries, Ltd. ("SEI"), where he has been engaged in research and development of electrodes for electrical discharge machining. Since October 2003, he has been working in this field on loan from SEI to A.L.M.T. TECH Inc., a wholly-owned subsidiary of SEI. Mr. Goma is currently working in the Metal Products Engineering Group, Composite Alloy Division of A.L.M.T. TECH Inc. as an employee of SEI.

2) In order to demonstrate that the present invention of the above identified patent application achieves results that are significantly improved and unexpected in comparison to the prior art of US Patent 4,027,134 (Arakawa et al.), Mr. Goma conducted certain experiments to prepare and evaluate comparative samples according to Arakawa et al. with inventive samples according to the present invention, as follows.

3) Comparative Samples (i), (ii) and (iii) were prepared with compounding ratios of input raw material powders as shown in the following table.

| | W Powder (%) | Cu Powder (%) | $Y_2O_3$ Powder (%) | BeO Powder (%) |
|---|---|---|---|---|
| Comparative Sample (i) | 86.7 | 6.7 | 6.7 | 0.0 |
| Comparative Sample (ii) | 92.3 | 6.7 | 0.0 | 1.0 |
| Comparative Sample (iii) | 87.5 | 6.8 | 0.0 | 5.7 |

4) The fabrication process and the conditions to prepare the Comparative Samples were as follows. The process of preparing the Comparative Samples included a step of using a 325-mesh sieve to sift the raw material powders, a mixing step and particularly a wet mixing step of mixing the sieved raw material powders in a stainless steel pot, another step of further mixing the raw material powder mixture with paraffin in an amount of 1% by weight with respect to the powders, a further sieving step of sifting the thus obtained mixture through a 100-mesh sieve, a molding step of molding the thus obtained mixed material into a predefined shape, and particularly by metal molding under a pressure of 0.8 to 1.5 t/cm$^2$ so as to obtain a desired alloy composition in a predetermined shape after sintering, followed by a step of degassing the sintered molded body in a hydrogen atmosphere at 450°C, and further a step of infiltrating Cu into the molded sintered body in a hydrogen atmosphere at 1300°C. Thereby the finished Comparative Samples were produced.

5) Description of each of the Comparative Samples:

Comparative Sample (i): A W-Cu alloy equivalent to "Sample No. 6" in "Table 2" in Arakawa et al. was fabricated, in view of the description in line 40 of column 3 to line 17 of column 4 and the description in lines 33-37 of column 4 in Arakawa et al. Namely, the final resultant composition of Comparative Sample (i) is 65% W, 30% Cu, and 5% $Y_2O_3$. Each of the input raw powders used to prepare the sample had a mean particle diameter as follows: W-13 μm, Cu-20 μm, and $Y_2O_3$-10 μm. After being weighed, these raw powders were sifted through a 325-mesh sieve.

Comparative Sample (ii): A W-Cu alloy containing 30% by weight of W, 0.77% by weight of Cu, and BaO, namely, having the same composition as that of inventive Samples 1 to 3 in Table 1 of the present application (see page 15 lines 19 to 26, and Table 1 on page 17), was fabricated by the manufacturing method described in Arakawa et al., as was carried out for the above-described Comparative Sample (i). Each of the raw powders used had a mean particle diameter as follows: W-13 μm, Cu-20 μm, and BaO-4 μm. After being weighed, these raw powders were sifted through a 325-mesh sieve.

Comparative Sample (iii): A W-Cu alloy containing 32% by weight of W, 4.15% by weight of Cu, and BaO, namely, having the same composition as that of inventive Sample 5 in Table 1 of the present application (see page 15 line 27 to page 16 line 6, and Table 1 on page 17), was fabricated by the manufacturing method

described in Arakawa et al., as was carried out for the above-described Comparative Sample (i). Each of the raw powders used had a mean particle diameter as follows: W-13 μm, Cu-20 μm, and BaO-4 μm. After being weighed, these raw powders were sifted through a 325-mesh sieve.

6) Results of evaluation of the Comparative Samples:

Comparative Samples (i) to (iii) were evaluated in the same manner and as to the same characteristics as described in relation to Table 1 of the present application (see page 17). The results are as follows.

| Comparative Samples | Oxide Particles | | ≤1 μm W Particle (%) | Electrode's Wearout Rate (%) | Machining Rate ($mm^3$/min) |
|---|---|---|---|---|---|
| | Mean Particle Diameter (μm) | Interparticle Spacing (μm) | | | |
| (i) | 13 | 25 | 0 | 19.2 | 2.01 |
| (ii) | 4.3 | 22 | 0 | 18.1 | 2.66 |
| (iii) | 4.9 | 19 | 0 | 17.5 | 2.68 |

The results of evaluation of inventive Sample 1 per Table 1 of the present application (see page 17) are as follows.

| Sample | Oxide Particles | | ≤1 μm W Particle (%) | Electrode's Wearout Rate (%) | Machining Rate ($mm^3$/min) |
|---|---|---|---|---|---|
| | Mean Particle Diameter (μm) | Interparticle Spacing (μm) | | | |
| 1 | 0.9 | 5 | 25 | 9.6 | 2.88 |

7) Discussion:

By comparing the above results of evaluation of the Comparative Samples (i), (ii) and (iii) with the results of evaluation of the inventive Samples such as inventive Sample 1 in Table 1 of the present application, it can be seen that samples prepared according to the method disclosed by Arakawa et

al. (in which the raw powders are sifted through a 325-mesh sieve) have oxide particles that do not necessarily achieve a mean particle diameter of less than 3 μm and a mean interparticle spacing of at most 14 μm. Particularly, the Comparative Samples (i), (ii) and (iii) have a mean particle diameter of 13 μm, 4.3 μm and 4.9 μm respectively, and an interparticle spacing of 25 μm, 22 μm and 19 μm respectively. This is true even when the Comparative Sample was prepared with an alloy material composition corresponding to that of inventive Samples, see present Comparative Samples (ii) and (iii). Furthermore, by comparing the results of the evaluation of the machining rate and the electrode wear rate, it can be seen that the Comparative Samples with a mean particle diameter of 3 μm or more and a mean interparticle spacing of greater than 14 μm achieve a significantly worse (higher) electrode wear rate with a worse (lower) machining rate than that of the inventive Samples according to the present application (mean particle diameter less than 3 μm and/or interparticle spacing at most 14 μm).

The above results demonstrate that sample EDM (Electrical Discharge Machining) electrodes produced according to the fabrication method disclosed by Arakawa et al. (with sifting the raw material powders through a 325-mesh sieve) have significantly larger mean particle diameters and mean interparticle spacings than the present inventive characteristic features (mean particle diameter less than 3 μm and/or mean interparticle spacing at most 14 μm), and as a result achieve significantly inferior results in productivity, i.e. a lower machining rate and a higher wear rate of the electrode in use. For example, while the inventive

Sample 1 has an electrode wear rate of 9.6% with a machining rate of 2.88 $mm^3$/min, the Comparative Sample (i) according to Arakawa et al. has a significantly higher electrode wear rate of 19.2% with a lower machining rate of only 2.01 $mm^3$/min. This electrode wear rate of the Comparative Sample (i) according to Arakawa et al. is two times (i.e. 200% of) the electrode wear rate of inventive Sample 1, while the inventive Sample 1 electrode operates with a machining rate that is 1.4 times the machining rate of the Comparative Sample (i). Such improvements are considered substantial and significant in the present field of electrodes for electrical discharge machining.

8) We have read the disclosure of US Patent 4,027,134 (Arakawa et al.) and from such prior art disclosure, it would not have been expected that the present significant improved results according to the invention could be achieved by ensuring that the electrode material has particles with a mean diameter less than 3 µm and/or an interparticle spacing of not more than 14 µm and especially preferably not more than 10 µm. In comparison to the prior art, the significantly improved results achieved according to the invention were unexpected at the time the invention was made. Particularly, it was unexpected that providing an electrode material in which the oxide particles have a mean particle diameter of less than 3 µm and/or a mean interparticle diameter of at most 14 µm and especially preferably at most 10 µm, can achieve substantially improved (reduced) electrode wear and improved (increased) machining rate during use, in comparison to the electrode produced as disclosed by Arakawa et al.

9) All statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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